CIGRE Study Committee B1

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

<table>
<tr><td rowspan="2">WG [1]N° B1.73</td><td colspan="2">Name of Convenor: Alexandra Burgos (ES)</td></tr>
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<tr><td colspan="2">Technical Issues #[2]: 9</td><td>Strategic Directions #[3]: 1, 2</td></tr>
<tr><td colspan="3">The WG applies to distribution networks[4]: Yes</td></tr>
<tr><td colspan="3">Potential Benefit of WG work #[5]: 1, 2</td></tr>
<tr><td colspan="3">Title of the Group: Recommendations for the use and testing of Fibre Optic Cables used in Land Cable Systems</td></tr>
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Scope, deliverables and proposed time schedule of the WG:

Background:

Fibre Optics are used in land power cable systems for communication purposes, but also for monitoring. The second purpose is becoming more relevant day by day because it provides information about the condition of the installation, allowing to anticipate possible faults, plan maintenance and optimize the use of assets.

Several aspects depend on the use of the Fibre Optics, such as:
- Type of fibre: single-mode, multi-mode
- Optimal location of the fibre optics in the installation: the closer the cable, the better (even embedded in it) when monitoring the temperature on the insulation; the more independent the cable and more accessible, the better, when using it for communication purposes.
- Qualification process.

Others depend on the construction and solution used (induction effects when using metallic materials, maintenance)

The WG will identify standards and recommendation already available for the use and testing of Fibre Optic Cables (FOC) used in land power cable systems, and will develop points not covered by them.

Close attention will be paid to the progresses of WG B1.70, which will cover the same topics but related to submarine cables instead of land cables. The coordination with this WG is needed in order to guarantee that the recommendations are aligned.

The possibility of joining members from D2 (Information systems and telecommunication) should be analysed.

Scope:

The following topics will be developed in the WG:

1. Design Considerations
   - Configurations/scenarios (direct buried/trench/HDD, HVAC/HVDC)
   - FO separately or embedded, depending on the application (communication, DTS, DAS)
   - Differences between land and submarine cables.
   - All Fibre Optic Cables constructions for <u>external</u> FOC
     - Tube material (steel, copper, non-metallic)

- Dielectric FOC
    - Material and properties of polymer layers
    - Position of FOC to HV cable
    - For monitoring, number of phases to be monitored, redundancy
    - Loose tube, tight buffer and other constructions
  - All fibre optic cables constructions for embedded FOC
    - Advantages and disadvantages compared to separate FOC
    - Tube material (steel, copper, non-metallic)
    - Induced voltage challenges, earth and x-bonding systems when metallic parts/tubes are used.
    - Dielectric FOC
    - Material and properties of polymer layers
    - Position of FOC to HV cable cross section
    - Coupling between FOC and other structures in the HV cable
    - Loose tube, tight buffer and other constructions
  - Accessories/Ancillaries
    - Joint electrical characteristics, for embedded FO (Short Circuit currents and temperatures/Earthing Design/Transient Voltage withstand)
    - Termination earthing (substation and converter station, transition to overhead lines). Landfall/transition joints are covered by WG B1.70.
    - FO Connectors / adapters
  - Fibre application:
    - Type of fibres: single-mode, multi-mode
    - Grade or step index fibre
    - Lengths of monitoring and length of communications. Requirements (accessibility, maintainability, proximity to the power cable….)

2. Bonding System (only for embedded FOC or external FOC with metallic parts)
   - Earthing requirements at joints and terminations based on cross/solid/single point bonding (currents/resistances/voltages)
   - Current and voltage minimum insulation and short circuit requirements for the earth connection
   - Health and Safety implications during maintenance and repairs adjacent assets

3. Induced Voltage (only for embedded FOC or external FOC with metallic parts)
   - Standardised form of calculation that would be accepted by suppliers and clients (under continuous operating and short circuit conditions)
   - Comparison between generic designs:
     - Copper tube
     - Stainless steel tube
     - Armour or reinforced layer over metallic tube

4. Qualification of the FOC and Testing
   - Type Acceptance Test – optical testing before and after mechanical conditioning. Acceptance criteria.
   - FOC design life, formal verification and basis (ageing by heat), Halogen free, fire resistance.
   - Evaluate if strain/stress measurements should be required

5. Factory Process and Acceptance Tests
   - Joint - maximum attenuation value (two way)
   - Manufacture process controls (fibre strain monitoring)
   - OTDR at set wavelengths (two way) after layup

- Eddy current monitoring during manufacture of the external FOC, only if metallic tube
  - Ultrasonic detection of defects in FOC corrosion protection
  - Evaluate recommendation/standards for manufacturing processes.
  - Determine the fibre excess length, to be used for future references after installation.
  - Recommendations for acceptance tests

6. Commissioning
   - Recommendations on installation
   - Joint - maximum attenuation value (two way)
   - Evaluate if strain measurements are needed. Multiple wavelength OTDR/Brillouin OTDR
   - OTDR at set wavelengths (two way) analysis of the trace and event log
   - Power meter attenuation test, if relevant
   - Check earthing and measure resistance from metallic tube to earth at terminations, if metallic parts are present in FOC.
   - Evaluate if a baseline DTS should be made, before load switched on
   - Require documenting details of the installations activity (i.e. fibre coils, positions and lengths)
   - Require having a global scaling factor of the FOC to the HV cable.
   - Requirements for monitoring calibration

7. Operation and Maintenance
   - OTDR (on regular bases and on specific events)
   - Check earthing (visual inspection to check for damage/arcing) and measure resistance from metallic tube to earth at terminations, if metallic parts are present in FOC.
   - Evaluate recommendations of DAS, DTS and others, and define limitations of such equipment (length ranges, accuracy…)
   - Maintenance recommendations of the monitoring equipment (calibrations, part replacements…).

Deliverables:

☒ Technical Brochure and Executive Summary in Electra

☐ Electra Report

☒ Tutorial[6]

☐ Webinar[6]

Time Schedule: start: Nov 2019 **Final Report**: End 2021

Approval by Technical Council Chairman:

Date: November 19th, 2019

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3]See attached Table 2, [4] Delete as appropriate, [5] See attached Table 3,
[6] Presentation of the work done by the WG

Table 1: Technical Issues for creation of a new WG

1	Active Distribution Networks resulting in bidirectional power and data flows within distribution levels up to higher voltage networks
2	Digitalization of the Electric Power Units (EPU): Real-time data acquisition includes advanced metering, processing large data sets (Big Data), emerging technologies such as Internet of Things (IoT), 3D, virtual and augmented reality, secure and efficient telecommunication network
3	The growth of direct current (DC) and power electronics (PE) at all voltage levels and its impact on power quality, system control, system operation, system security, and standardisation
4	The need for the development and significant installation of energy storage systems, and electric transportation, considering the impact they can have on the power system development, operation and performance
5	New concepts for system operation, control and planning to take account of active customer interactions, and different generation types, and new technology solutions for active and reactive power flow control
6	New concepts for protection to respond to the developing grid and different generation characteristics
7	New concepts in all aspects of power systems to take into account increasing environmental constraints and to address relevant sustainable development goals.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics
9	Increase of right of way capacity through the use of overhead, underground and submarine infrastructure, and its consequence on the technical performance and reliability of the network
10	An increasing need for keeping Stakeholders and Regulators aware of the technical and commercial consequences and keeping them engaged during the development of their future network

Table 2: Strategic directions of the Technical Council

1	The electrical power system of the future: respond to speed of changes in the industry
2	Making the best use of the existing systems
3	Focus on the environment and sustainability
4	Preparation of material readable for non-technical audience

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.
7	Work addressing environmental requirements and sustainable development goals.